BANGALORE ELECTRICITY SUPPLY COMPANY LIMITED

(Wholly owned by Government of Karnataka Undertaking)

UNDER GROUND CABLE FAULT DETECTOR FOR BMAZ AREA

TECHNICAL SPECIFICATION FOR SUPPLY OF VEHICLE MOUNTED FULLY AUTOMATIC HT & LT UG CABLE FAULT LOCATING EQUIPMENT UP TO 33kV FOR BMAZ AREA.

1 **SCOPE:**

1.1 This specification is intended to cover the design, manufacture, assembly, testing at manufacturer's works, supply, delivery, installation & commissioning of Special General-Purpose Van Mounted Fully Automatic Cable Fault Locating Equipment Suitable for Locating Fault on Low /Medium / High Voltage underground Power Cables up to 33 KV Complete with all materials and accessories for efficient and trouble-free operation.

1.2 All functions should be centrally controlled and monitored via integrated industrial PC running on users friendly based Operating System with suitable Anti-virus and cyber security.

1.3 **Standards:** The equipment shall confirm to the latest edition of the relevant standards. Bidders shall mention the applicable standard and shall furnish two copies of authenticated English version of the standards along with the offer

2 Functions of the system

2.1 The following functions should be performed and controlled via fully automatic centrally controlled unit by using single button/click

- Integrated Insulation testing
- DC Testing
- Pre location of Fault.
- Breakdown Voltage recognition.
- Sheath testing and sheath fault location
- Burning

Continuously variable surge generator in steps of 0 to 8, 16, 32 kV with surge energy of 3000 joules or more @ 8/16/32KV

2.2 **Different methods of fault pre-location methods**

- Insulation resistance method
- Time Domain Reflectometry Method (TDR)
- Capacitive Discharge (Thumping)
- Surge Arc reflection/ Burn Arc reflection/Burning method
- Impulse current method (Also Surge pulse reflection)
- Impulse current differential method
- Other fault locating techniques if any.

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2.3 **Pin-pointing methods:**

- Acoustic pin-pointing
- Audio frequency-based pin-pointing
- Wire/Wireless connectivity pin pointing set
- Cable tracing

2.4 **System software:**

The cable fault analysis shall be done automatically via a software controlled fully automatic mega-ohm meter with 1KV or above IR – test voltage and a powerful 3 phased Time Domain Reflection measurement (TDR).
The fault pre-location system must be integrated part of the entire system providing simultaneous control of system, HV generator and cable fault location function.
Automatic features should guide and support the operator during the complete fault location and testing procedure.
The system software shall be based on a solid industrial PC design, equipped with Pentium i5 or high speed latest generation processor or comparable processor and shall use operating system for easy data communication and handshaking with other systems. The TDR should use at least 400MHz data rate and a high dynamic range.

The 3-Phased TDR output must provide at least CAT IV/400V input protection.

A dashboard surface shall be provided to display the GPS Based Mapping system for exact determination of cable routes and fault location, existing diagnostic information and reports. The map supported system shall allow drawing the details of a cable route according to exact map records.

Provision shall be made to import GIS data including cable details and the geographical information of the cable routes shall be imported.

All software functions for fault analysis, cable fault pre-location, control for fault pinpointing, and shall be controlled via a Single rotary knob/Key board or mouse.

The geographical map shall be integrated in the same software and operating system.

2.5 **Package should be included Geo based Map and Data Base**

a) GPS Based Map

- The unique combination of maps, including cable routes
- GPS-based display of the system position, the cable route and faults
- Roadmap display via GPS
- Display of the cable route and faults on the map
- The position of the system should be determined via GPS and displayed on the map.
  Generates a graphical display of the cable and its accessories, the end of the cable and known fault positions, in relation to the cable layout

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b) Cable Data Base

- The Cable Data Base should allow the creation of a specific data base that contains all cable details, its history and test and diagnostic results
- Available data should be importable from GIS systems
- Cable data such as geographic position, voltage levels, joints, measured values, etc., should automatically be stored and remain accessible, any time.

Provision shall be made to update the new cable joints.

2.6 Cable Fault Location Guide

The Cable Fault Location Guide should be designed to guide operators through the cable fault location and testing process. Just by entering the most common cable parameters; such as nominal voltage, cable length and the available details from the manufacturer Cable Data Base, the system should determine the correct test parameters and procedures which then only need the final confirmation for application of the operator.

All performed test and measurement results shall be considered for the next following steps of the fault location approach and finally should be automatically saved in the memory and become part of the fault location sequence.

The pre-located location of the fault should be geographically displayed as the fault pin-pointing position on the GPS based map so as to identify the fault location. Reporting function should require few clicks to generate a final report.

- A Cable Fault Location Guide should lead the user step by step – quickly and efficiently – to the cable fault.
- It shall be an intelligent fault location process to help the operator by adjusting the proposed fault location procedure in dependence of the fault situation.
- The automatic fault analysis should provide clear graphical presentation and thus a good overview for the user.
- The system should also recommend the parameters of voltage levels in relation to the cable rating and the fault characteristic.
- The system shall contain a voltage assistant with pre-defined testing voltage parameter according to the rating of the cable.
- The system must select and recommend the voltage levels based on the entered cable data and the fault type.
- Facility for user configurable voltages levels shall be provided.
- The automatic cursor positioning function shall indicate the cable end and the fault position.
- Facility for automatic setting of method-related parameters such as pulse width, gain, pre-trigger, view range, etc. for fast and efficient fault location shall be provided.
- Clear graphical presentation of the measurement results with helpful functions such as zoom, superimposing of multiple graphs, individual curve movement for the analysis is required.
- Facility shall be given to the user to deviate in any part of the fault process instead of following the recommendation.
- The system shall have over voltage and under voltage protection of mains supply and HV should not get ON in case of over and under voltage.

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- Memory: Automatic storage of data and a min of 1,00,000 data storage facility of all test data shall be provided.
- The entire system shall be mounted on suitable vehicle with back door safety, during the operation if door gets open accidently then instrument should sense it & stop the HV immediately
- Mounting Van for the Comprehensive Set: All the Units of the Comprehensive Van Mounted Multifunctional Cable Fault Locator system consisting of, Pre-Location, burning unit, Pin-pointing & Testing of HT & LT cables shall be mounted on a suitable frame with Power Supply connection arrangement in suitable white board Vehicle if Diesel Driven with authorized modification certificate.
- Local service Engineer should be available in the jurisdictional area for giving service support.

2.7 **The offered system should consist of several functional modules**

These are:

- Industrial PC with manufacturer System Software of user friendly with Virus/cyber-attack protection with UPS if necessary
- 3 Phase Time domain reflectometer
- LV connector panel
- HV coaxial connection sockets
- Cable drum rack with connection cables
- Operating desk with drawers
- Surge Generator
- Pin pointing

3 TECHNICAL PARAMETERS REQUIRED IN THE SYSTEM

3.1 Function of the system

The following functions has to be performed and controlled via fully automatic centrally controlled unit by using single button/click

a) Integrated Insulation testing.
b) DC Testing
c) Pre location of Fault
d) Breakdown Voltage recognition
e) Sheath Testing
f) Burning

3.2 Fault pre-location with following methods

a) Time Domain Reflectometry -3 Phase TDR
b) Secondary/Multiple Impulse Method (SIM/MIM)
c) DC- Testing
d) Impulse Current Method ICM
e) Burning – Current of 32Amps and Voltage of Min10kV
f) If any other fault locating method

3.3 Pin-pointing methods consisting of following features

a) Acoustic pin-pointing
b) Audio frequency-based pin-pointing

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3.4 **System Software with following parameters**

a) The cable fault analysis has to be done automatically via the inbuilt latest user friendly interface with suitable operating system free from virus/cyber-attacks which is controlled fully automatic mega-ohm-meter with Min 1KV IR– test voltage and a powerful 3 phased Time Domain Reflectometer (TDR).

b) The fault pre-location system must be integrated part of the entire system providing simultaneous control of HV generator and cable fault location function.

c) The necessary features have to be provided to guide and support the operator during the complete fault location and testing procedure.

d) The system has to be based on a solid industrial PC design, equipped with appropriate latest high speed comparable processor (Minimum i5 core) and shall use user friendly operating system for easy data communication and handshaking with other systems. The TDR should use at least 400MHz sampling rate and a high dynamic range.

e) The TDR output must provide at least CAT IV/400V input protection.

f) All software functions for fault analysis, cable fault pre-location shall be controlled from one common software on a single control IPC. The software shall be controlled through key and board mouse facility.

g) Any up-gradation in the software in future after supply, life time software assistance support shall be provided by supplier without claiming any extra charges.

3.5 **Pre-Locator with following parameters:**

a) TDR pulse width: **20ns – 1.3** Mili-Sec or more
b) Measuring pulse: **20V – 200 V**
c) Output impedance: **8 – 2000** Ohm or more
d) Sampling rate: **400 MHz or more**
e) Input signal gain: Dynamic range min 70dB (-10 to +60dB)
f) SIM/MIM: **Min 20 TDR** multi-shot measurements
g) Display range: **10m – 1000** km or more
h) Resolution (@ v/2 = 80 m/µs): 0.1 m
i) Accuracy: 0.1% of measuring result
j) Propagation velocity factor v/2 range:20–150 m/µs adjustable.
k) Size of screen: **17"** or more
l) Monitor: LCD/LED display
m) Ambient temperature (operational): 0 to +50 °C
n) Storage temperature: -20 to +60 °C
o) Power supply: 100 – 260 V, 50/60 Hz
p) Power consumption: 300VA (Max)
q) IR test:
- Test voltage: upto 1kV or more
- Measuring range: up to 5Giga-Ohm range and simultaneously measuring Phase to Phase and Phase to Neutral. (R-Y, Y-B, R-B, R-N, Y-N, B-N)

3.6 **Surge Voltage Generator with following parameters:**

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0 – 8, 0 – 16, 0 – 32 kV Surge Energy: **3000J** or more @ 8/16/32KV
DC Voltage: 0 – 32 KV
Surge sequence: 5– 20 surges/min., single surge
Capacitor Charging rate: 1000J/Sec min

Surge Generator Unit:

The surge generator unit should be used as thumper for charging of cable under test (i.e., defective cable) till sufficient flashover is achieved at the point of fault. The set should be used in conjunction with surge receiver

(a) Surge Voltage Range: 0–8 KV, 0–16 KV & 0–32 KV

(b) Surge Energy: 0-8, 0-16, 0-32KV: **3000 J** in each step.

(c) The set should be provided with standard safety features like', 'High voltage ON lamp', automatic grounding upon shutdown, Auto-OFF in case of power supply break and overload protection with circuit breaker etc.

(d) The unit should be compatible for use with Surge Receiver Unit and Arc Reflection Unit.

(e) The unit should include mains leads, earth cable, HV connecting cable, earth terminals, battery connecting cables with battery clips, all required and related accessories with carrying case and user's manual with complete operating and maintenance instructions.

g) Impulse: 0-32 kV in suitable steps of 0-8/0-16/0-32 kV and each step continuously variable.

h) Surge Energy : **3000Joule (Min)**

i) Impulse interval: Single shot, 5 to 20 pulse per minute.

j) Capacitor charging rate shall be at least 1000J/Sec. in order to fully charge the capacitor.

g) **Safety Protection:**
- 2 automatic discharging devices (Internal & External)
- Reliable operated surge switch electromagnetic operated
- Safety control circuit according to VDE 0104

3.7 **Filter unit for SIM/MIM:**

Since pulse echo or reflection may not be suitable for high impedance or resistance faults. Thus, keeping in view, a suitable band pass filter unit should be supplied to stabilize the ARC at the flashover or the point of fault.

The offered filter must simplify the operation causing less stress, causing minimum damage on the tested cables to detect the high resistive faults. There should be complete compatibility of TDR, Surge Generator/Thumper with the filter unit. This unit must filter or stabilize the arc at the fault point and record the same in the supplied TDR to compare it with previous trace recorded without the filter unit in the same core. Suitable coupler for coupling the filter unit with the TDR and Surge generator must be supplied. The offered filter must contain switching elements necessary for the triggering and the coupling of the pulse. After the pre-location using the SIM/MIM method, there must be a decoupling element which must by pass the surge generator for making it ready for use in pinpointing the cable fault. The control unit should connect automatically the filters with appropriate coupler with

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the surge generator and TDR when SIM/MIM mode.

3.8 **Inductive coupler:**

Inductive Coupler required for pre-location of high resistance faults with a Surge Voltage Generator according to the Impulse Current Method (ICM).

3.9 **Surge Wave Receiver Unit /Pin pointer – 2 sets**

It should function as a directional acoustic listening device for pinpointing of flashover faults in underground power cables. It should have the following features:

1. The unit should be handy & rugged, and should comprise of receivers, headphones, sensors, amplifiers and any other auxiliary item as necessary for operation of the unit. The set should provide detection of both acoustic and electromagnetic pulses emitted from an arcing fault when it is surged.
2. The set should be able to determine the proximity and direction to the cable fault by measuring electromagnetic surge and acoustic emission.
3. The set should be able to measure the time delay between acoustic and electromagnetic signals.
4. In the acoustic mode the set should have Automatic Noise Suppression feature to eliminate complete background noise.
5. It should be able to pinpoint the exact location of the fault.
6. The instrument should be rechargeable battery operated.
7. The set should have mute feature to activate while in motion.
8. It should have adjustable feature for adjusting the electromagnetic gain & acoustic gain.
9. It should have an LCD display with backlit feature.
10. The unit should be provided with acoustic headphone set to receive the acoustic signal for pin pointing the fault point.
11. The LCD display should indicate the cable route through the electromagnetic signal in bar graph form & the proximity to fault point by a numeric display.
12. The communication between receiver instrument and ground microphone shall be done via a Wired/wireless connection. (For wired additional 3 Nos. each shall be provided). The communication between the head phone and receiver instrument should be wireless.
13. The unit should include lightweight receiver with carrying straps, handy sensor, all required and related accessories with carrying case and user's manual with complete operating and maintenance instructions with flowing features:

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a) Acoustic method
b) Digital indication of proximity of the fault
c) Cable depth measurement in combination with the surge coil
d) Water-resistant design
e) Integrated head phone
f) Large illuminated LCD display
g) Automatic digital filters for suppression of traffic noise
h) Easy menu operation
i) Lightweight
j) Accurate route tracing

3.12 **The offered system consisting of following functional modules**

a) Central Control Unit
b) Mains & Safety Control Unit
c) Industrial PC with latest higher generation operating system with UPS
d) 3 phase Time domain reflectometer (TDR)
e) LV connector panel
f) HV coaxial connection sockets
g) Cable drum rack with connection cables
h) Operating desk with drawers
i) Fully Automatic Multi-Functional Surge Generator
j) Geo Based Map to find roadmap (via) GPS, cable route and fault on the map, system position as mentioned in above under clause **2.5**
k) Cable Database that allows the creation of specific cable details database, its history, testing results
l) Cable fault location Guide as mentioned in above under clause **2.6**
m) GSM connection module with Team Viewer® functions for remotely control the entire system to troubleshoot any errors. The user should have Licensed Team viewer.

3.13 **Safety Measure:**

The control unit should provide visual indication of failure of safety circuits/incorrect selection etc. with possible corrective methods. Constant monitoring of all safety circuits such as earth monitoring circuit etc. should be inbuilt into the control unit, safety interlock monitoring etc. Safety function should be incorporated in the vehicle suitably.

The instrument should have a built-in automatic discharge feature as per which a cable (installation) has to be safely discharged after a high voltage test. An emergency button on surge generator shall be provided to disconnect all equipments. All equipments shall be discharged on supply failure of disconnection of the unit.

The system shall be designed in such a way so as to be mountable on a vehicle in such a way that the operating personal safety is ensured by strict separation of operating equipment and high voltage compartment.

Input voltage proof display up to 400V and current drawn by the equipment display is necessary.

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Fuse units for each circuitry is essential and also be easily accessible so as to enable the operator to replace the fuse unit if required.

The equipment should not operate High Voltage, unless proper earthing is provided.

The suitable protection unit shall be provided to equipment in case of testing of enrgized cable. (HV protection shall be provided to the equipment).

3.14 **Mounting Van for the Comprehensive Set:**

All the Units of the Comprehensive Van Mounted Multifunctional Cable Fault Locator system consisting of Cable Fault conditioning (burn-down), Pre-Location, Pin-pointing & Testing of HT & LT cables shall be mounted on a suitable frame with Power Supply connection arrangement in suitable white board if diesel driven Vehicle with authorized modification certificate

3.15 **Mounting, Pre wiring and Mechanical fittings on Van:**

Steel frame for mounting the following instruments:

i) Computer Aided fault locator

ii) High pressure test: All the equipment should be mounted on steel frames.

iii) Rotating cable drums should be provided for:

- HV cable drum -50m or more
- Mains cable drum -50m or more
- Earthing cable drum-50m or more
- Auxiliary earthing drum-25m
- TDR measurement cable drum-25m

iv) Safety screens to be provided to isolate the HV area from operating area.

v) Suitable cupboards and tables for storing hand held instruments, writing desk.

vi) Diesel driven van/EV/CNG

vii) Fully Insulated floor for safety.

3.16 **Fabrication of CABLE FAULT LOCATING equipment shall be on TEMPO Traveller/TATA Winger or equivalent vehicle, EV/ Diesel/ CNG.**

Vehicle will be fabricated as per standard fabrication practice as specification confirming to All India Motor Vehicle's Act.

Provisions of standards fitment will be kept such as first aid box, Fire Extinguishers, Rear Bumpers, Stephaney, cradle, Tool box, Rear view mirrors, reverse camera, operator chair and seating arrangements for 3 Nos. AC (working on external supply), side indicators 02 Nos. Fans working on DC, proper illumination in the van and other necessary tools & accessories if any. The Stickering/ Branding of Company name with logo (BESCOM) (will be intimated in the Purchase order) and etc.

The registration of vehicle shall be of **white board** only, if Diesel driven Vehicle with authorized modification certificate from RTO shall be produced along with vehicle documents.

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3.17. **Generator-set:**

Generator set, space for generator set and necessary wiring shall be provided for 3.3kV Generator with suitable fabrication for mounting.

3.18 **Mandatory Tools:**

a) Discharge rod
b) Measuring wheel
c) Earth spikes
d) Digital multi-meter
e) Set of spanners, screw Driver, Allen Key set, Safety Hand Gloves shall withstand capacity upto 32kV (2 sets) etc.,

3.19. **I. Others:**

Vehicle shall be fabricated as per standard fabrication practice as specification confirming to All India Motor Vehicle's Act.

Provisions of standards fitment shall be kept such as first aid box Fire Extinguishers, Rear Bumpers, Stephaney, cradle, Tool box, Rear view mirrors, reverse camera, operator chair and seating arrangements for 3 Nos. AC (working on external supply), side indicators 02 Nos. Fans working on DC and proper illumination in the van. The Registration of vehicle shall be **white board** only if Diesel Driven, Stickering/Branding of Company name with logo (BESCOM) (shall be intimated in the Purchase order) and etc.

II. Guarantee (For Vehicle):

Not withstanding to that specified in this Specification, the supplier is responsible to provide all necessary component for satisfactory working of the system in locating the fault in the cable. The vehicle should be Guarantee as per the Manufacturers Specifications. The supplier shall have to offer to BESCOM the same standard guarantee card of the principal manufacturer of the vehicle. Registration of the vehicle in shall in the name of alloted BESCOM Division/Circle with white board registration.

III. Guarantee:

The equipment shall be **guaranteed** for the satisfactory performance and against failure due to bad design, bad materials and defective manufacturer or bad workmanship for a period of 60 months with 10% total contract value as performance Bank guarantee payable at Bangalore from the date of commissioning. The supplier shall repair/ replace the faulty equipment / components free of cost in case of failure during the guarantee period. Further, all the supplied cable fault locating machines to have comprehensive onsite guarantee (inclusive of parts and labor) for 5 years 6 months from the date of supply or 5 years from the date of installation & commissioning.

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IV. Certificate and instruction book.

The following documents shall be given in English along with each equipment.

- Printed pamphlets /Catalogues.
- Instruction manuals.
- Drawings (Layouts and circuit diagrams) etc. of each and every unit and sets
- Test certificates
- Guarantee card
- Copy of type test reports of the equipment
- Any other relevant documents

V. General:

1. The supplier should forward relevant technical data and operating manual of the equipment offered.
2. A list of various clients to whom similar equipments are supplied also may be sent with the offer.

A) **Service Center:** The Manufacturer shall have Full-fledged service facility operational in India to provide necessary service. The supplier shall attend and repair the equipments after receiving the calls/complaints within 24 hrs of written/ Email/ Telephonic complaint and faulty spares shall be replaced within 15 days from the date of complaint.

B) **Service Engineers:** The supplier shall provide good and qualified service engineers to assist BESCOM employees during the guarantee period hereafter.

C) **Spares:** The service center should be equipped with sufficient spares which suits the equipments for a minimum period of ten years.

D) **Training & familiarization programme:** The supplier shall provide on site training and familiarization programme at free of cost to the BESCOM employees as per specification, guaranteed technical particulars of all equipment and operational functions of all accessories. The training / familiarization programme period shall be a minimum period of two weeks and it should also cover trouble shooting techniques in the equipments/ accessories/ field for locating cable fault. Training and familiarization programme has to be arranged as and when requested by BESCOM at free of cost.

VI. Inspection:

The stages of manufacturing process of equipment shall be inspected/tested/witnessed in the presence of BESCOM Engineers at original equipment manufacturer's (OEM's) premises. After completion of manufacture the equipment shall be inspected/ tested/witnessed in the presence of BESCOM Engineers at supplier/ manufacturer's premises. The test shall be conducted as per relevant standards. The entire cost towards testing shall be borne by the supplier. The supplier shall intimate 30 days in advance for inspection/ testing to BESCOM, to arrange for the same.

General Manager (El.)
QS&S, BESCOM 03/01/25